

NAME P/N QTY	CRIT	FAILURE MODE & CAUSES	FAILURE EFFECT	RATIONALE FOR ACCEPTANCE
104FM13Z WAIST BEARING, ITEM 104 ----- A/L 10057-03 (1) OR ----- A/L 10043-04 (1)	2/1R	Waist bearing seal gas leakage. Contamination wear or deterioration of the pressure seals, inadequate seal squeeze.	END ITEM: None for a single failure. For dual seal failure, suit gas leakage to ambient. GFE INTERFACE: None for a single failure. For a dual seal failure, depletion of primary O2 supply and SOP. Rapid depressurization of SSA beyond SOP makeup capability. MISSION: None for a single failure. CREW/VEHICLE: None for single failure. Loss of crewman with loss of both primary and secondary pressure seals.	A. Design - Contamination is precluded from entering the waist bearing assembly by two teflon environmental seals, one on each side of the bearing assembly. These seals fit into mating grooves in the inner and outer races and form a barrier to preclude introduction of contamination into the pressure seals and ball raceway areas. The pressure seals are made from polyester polyurethane and are lightly lubricated with Brayco 814z oil to preclude wear. Vespel balls act as ball separator/spacers. Each seal cross section provides minimum of .028" and maximum of .038" of seal squeeze to maintain positive operational pressure. When pressurized, the seals expand to seal firmly against the bearing races to ensure a maximum bearing leak of 6.0 sccm and a torque that will not exceed 110 in- lbs when installed in the lower torso. B. Test - Acceptance: The waist bearing is subjected to testing per Airlock ATP 10043 of airlock with ILC source verification. the primary and secondary seals are proof pressure tested with the bearing in the test fixture. The fixture is pressurized to 8.0 (+0.2-0.0) psig and held for 5 minutes. Following proof pressure testing, the bearing is pressurized to 4.3 +/- 0.1 psig, testing the primary and secondary seals separately, and subjected to cycle rotation. leakage is verified to be less than 6.0 scc/min. the bearing is installed on the ILC lower torso fixture and pressurized to 4.3 +/- 0.1 psig. testing both seals separately, breakaway torque of less than 80 in-lbs and running torque of less than 110 in-lbs are verified. leakage of less than 46.5 sccm is verified. PDA: See Acceptance Test Procedures. Certification: The dual seal waist bearing successfully passed SSA certification testing (manned) to duplicate operational life (Ref. "1153 Hour Cert Report for Redesigned Dual Seal Waist Bearing, ILC Doc 0111-719428). The following usage, reflecting requirements of significance to the waist bearing, was documented during certification: Requirement S/AD Actual ----- ---- ----- Pressure Hours 458 1200 Pressure Cycles 300 1080 Waist Rotations 2466 7200 Walking Steps 4320 77760* * The walking steps were accomplished during the Enhanced Certification Testing (Ref. ILC Doc 0111-711330). In addition, the bearing has been subjected to screening tests where the bearing is bench cycled to a crew familiarization test profile with constant leakage monitoring. The bearing passed this test with both seals functioning and with one seal intentionally disabled.
		TIME TO EFFECT /ACTIONS: Seconds.		
		TIME AVAILABLE: N/A		
		TIME REQUIRED: N/A		
		REDUNDANCY SCREENS:		

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		104FM13Z	A-PASS B-N/A C-PASS	<p>Both seals in the cert bearing have been subjected to a proof pressure test at 8.0 psi.</p> <p>C. Inspection - Components and material manufactured to ILC requirements at an approved supplier are documented from procurement through shipping by the supplier. ILC incoming receiving inspection verifies that the materials received are as identified in the procurement documents, that no damage has occurred during shipment and that supplier certifications have been received which provides traceability information.</p> <p>The following MIP's are performed during the waist assembly manufacturing process to assure the failure cause is precluded from the fabricated item: 1. Visual inspection of the pressure seal and environmental seals for gouges, nicks, tears or degradation. 2. Verification of cleanliness to VC level. 3. Visual inspection after proof and leakage testing for deformation, defects or damage.</p> <p>During PDA, the following points are performed at the LTA assembly level in accordance with ILC Document 0111-70028J: 1. Visual inspection for VC level cleanliness and material degradation. 2. Visual inspection for structural damage following proof pressure test. 3. Verification of bearing torque less than 110 in-lb at 4.3 +/- 0.1 psig.</p> <p>D. Failure History - No history of this failure mode to date (leakage beyond SOP makeup capability). Failures have occurred with the single seal aluminum bearing (A/L 9698-08) that were within SOP make-up capability. J-EMU-104-C001 (07/28/80). Waist bearing leak. Improper assembly. J-EMU-104-005 (12/07/83). Waist bearing leak (4500 SCCM) in chamber. Insufficient seal squeeze. Wide-lip seal was incorporated per ECO-851-0008. J-EMU-104-006 (03/23/84). Waist bearing leak (6,400 SCCM) in chamber. See (2) above. I-EMU-104-C006 (02/13/85). Waist bearing seal leak. Incomplete removal of mold flash. Note added to drawing to inspect seal with magnification. J-EMU-104--010 (04/12/85). Audible leak approx 71,000 SCCM. Improper installation of seal. Procedures changed to require bearing rotation (720 degree) prior to test. J-EMU-104--013 (2/11/86) spare waist bearing separator seals shipped to jsc without leakage test. leakage requirement added to all separator seal drawings. J-EMU-104--014 (2/11/86). See J-104--013 J-EMU-104--015 (2/11/86). See J-104--013 J-EMU-104--016 (2/11/86). See J-104--013 J-EMU-104--017 (2/11/86). See J-104--013 J-EMU-104--018 (2/11/86). See J-104--013 J-EMU-104--019 (2/11/86). See J-104--013 J-EMU-104--020 (2/11/86). See J-104--013 J-EMU-104--021 (2/11/86). See J-104--013 B-EMU-104--A016 (8-4-87) Foreign substance molded into separator seal. ECO 871-0530 improves bearing seal inspection methods. B-EMU-104-A020 (4/28/88). waist bearing leak during 11 ft vacuum chamber treadmill test. Corrective Action: See B-EMU-104-T001.</p>

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		104FM13Z		<p>B-EMU-104-A021 (5/9/88). See B-104-T001 B-EMU-104-A022 (5/11/88). See B-104-T001 B-EMU-104-T001 (8-19-87) Waist bearing leak (13,700 SCCM) in chamber. Corrective Action: Implement the dual seal waist bearing. B-EMU-104-A024 (8/15/88) Secondary waist bearing seal failed leakage test due to contamination in seal groove generated when installing clamping ring screws. LTA assembly steps reordered per ECO 881-0844 to install clamping ring screws, clean inner race assembly, then finish assemble the ball bearing. B-EMU-104-A040 (6/8/95) After installation of a new lip seal, waist bearing S/N 120 failed primary seal leakage test with 30.0 SCCM leakage vs. 6.0 SCCM spec. Exact failure cause could not be determined because bearing races in which the leak occurred were not investigated. No corrective action taken. B-EMU-104-A054 (03/22/98) The Lower Torso Assembly failed leakage testing due to leakage at the waist bearing primary seal. Inspection of the seal revealed wrinkling along the sealing lip which can compromise sealing. Adequate anti-wrinkling caution notes are contained within the Maintenance Manual. No corrective action taken.</p> <p>B-EMU-104-A057 (6/22/98) - Primary and secondary seals failed leak test. Spec: 6.0 SCCM max. Act: 16.0 SCCM, 7.7 SCCM, respectively. Cause and corrective action could not be proven due to inconsistent leak test results. Probable causes of leakage could have been rough spots on the seal lips. Seal molds were blemished, causing rough spots. Differences in orientation of machining marks on test fixture and bearing may have contributed to inconsistent leak test results. Seal molds were cleaned and inspected. A/L specification PS1211 modified to require inspection of mold surfaces prior to molding each seal. Photographs for visual comparison inspection of seals has been added to A/L PS1188. Additionally, pre-flight visual inspections and leakage tests per FEMU-R-001 exist to identify anomalies.</p> <p>E. Ground Turnaround - Tested for non-EET processing per FEMU-R-001, Pre-Flight Test Requirements, LTA Leakage. None for EET processing. Additionally, every 4 years or 229 hours of manned pressurized time, the waist bearing is disassembled, inspected, cleaned, lubricated, reassembled and subjected to torque, structural, and leakage tests.</p> <p>F. Operational Use - Crew Response - EVA: No response, single failure not detectable. Pre/Post EVA: No response, single failure not detectable. Training: No training specifically covers this failure. Operational Considerations: Flight rules define EMU Go/No-go criteria related to pressure integrity.</p>

EXTRAVEHICULAR MOBILITY UNIT
SYSTEMS SAFETY REVIEW PANEL REVIEW
FOR THE
I-104 LOWER TORSO ASSEMBLY (LTA)
CRITICAL ITEM LIST (CIL)

EMU CONTRACT NO. NAS 9-97150

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